Department of the Army
Pamphlet 621–10

EDUCATION

ARMY SKILL DEVELOPMENT PROGRAMS

Headquarters
Department of the Army
Washington, DC
1 August 1979

UNCLASSIFIED

SUMMARY of CHANGE

DA PAM 621–10
ARMY SKILL DEVELOPMENT PROGRAMS

Not applicable.

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ARMY SKILL DEVELOPMENT PROGRAMS

By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

Official:

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Administrative Assistant to the Secretary of the Army

History. This publication has been reorganized to make it compatible with the Army electronic publishing database. No content has been changed.

Summary. The purpose of this pamphlet is to provide guidance and information concerning— acquisition and property accountability of equipment needed in implementing on-post Skill Development Programs; and evaluation criteria for standardization of course programs.

Applicability. Not applicable.

Proponent and exception authority. The proponent agency of this regulation is the US Army Adjutant General Center.

Interim changes. Interim changes to this pamphlet are not official unless they are authenticated by The Adjutant General. Users will destroy interim changes on their expiration date unless sooner superseded or rescinded

Suggested Improvements. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to HQDA (DAAG–EDS) WASH DC 20314.

Distribution. To be distributed in accordance with DA Form 12–9A requirements for AR, Education.

*Active Army:*C
*ARNG:*A
*USAR:*C

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Section I
GENERAL

1. Purpose.

To provide guidance and information concerning—

a. Acquisition and property accountability of equipment needed in implementing on-post Skill Development Programs.

b. Evaluation criteria for standardization of course programs.

2. Scope.

a. This pamphlet covers the following vocational/technical areas: automotive technology, diesel technology, welding technology, electronics technology, and construction technology (e.g., carpentry, electricity, plumbing, and masonry).

b. Courses will be open to active duty military personnel including USAR and ARNG members serving on active duty or active duty for training. Military retirees, DOD civilians working on the installation, and dependents of active duty personnel may participate on a space available basis by meeting the tuition and course entrance requirements.

3. Objectives.

Skill Development Programs provide opportunities for soldiers to:

a. Participate in technically oriented courses in support of enlisted military occupational specialities.

b. Further vocational/technical development to qualify for certification in the trade or vocation.

c. Develop a skill which is both Army and civilian related that will assist in post-service employment.

d. Build academic credits toward associate degree requirement in a vocational field.

4. References.

a. a. DOD 4140.172–M (Military Standard Requisitioning and Issue Procedures (MILSTRIP).

b. DOD 4160.212–M (Defense Disposal Manual).

c. AR 6212–5 (Army Continuing Education System (ACES).

d. AR 7002–43 (Management of Defense-Owned Industrial Plant Equipment).

e. AR 3102–34 (Equipment Authorization Policies and Criteria and CTA).

f. SB 7002–20 (Department of the Army Supply Bulletin).

5. Program Standardization.

a. Standardization of course programs may be maintained by the development of course performance objectives recognized by the trade or vocation.

b. Standardization may be initiated through the contract negotiated with accredited educational institutions providing the course programs.

(1) Education Services Officers (ESOs) should include the following statement within the context of the "Statement of Work," Section 72–1951.1, Army Procurement Procedure (APP): "Contractors will include in the instructional curriculum of each Army Skill Development course program measureable performance objectives recognized by the trade or vocation." This criteria will assist the Contracting Officer and the ESO in the evaluation/selection of the contractor. Suggestions and assistance in the development of performance objectives may be obtained from various State vocational consortiums and such multiple-State consortiums as Mid America Vocational Curriculum Consortium, Inc. (MAVCC), 1515 West Sixth Avenue, Stillwater, OK 74074; and the Vocational-Technical Education Consortium of States (VTECS), Commission on Occupational Education Institutions, Southern Association of Colleges and Schools, 795 Peachtree Street, NE, Atlanta, GA 30308. (See section III below.)

(2) Course programs should provide a minimum of certificate in a program of study and, where applicable, the opportunity to pursue an associate degree. Appropriate trade tests should be provided, i.e., National Institute of Automotive Excellency (NIASE). Such tests, if not offered by the contractor, may be obtained through the Defense Activity for Nontraditional Education Support (DANTES).

Section II
EQUIPMENT ACQUISITION

Due to the high cost of skill development equipment, the solicitation should normally require the contractor to supply any equipment necessary in the Skill Development Programs. When the ESO has reason to believe insufficient bidders will respond to a solicitation requiring contractors to supply this equipment, the ESO will attempt to acquire the necessary equipment through the following sequence of sources (see para 42–45, AR 3102–34). (Equipment to be provided by the Government under the solicitation should be listed in the "Statement of Work" clauses set forth in APP 72–1951.1 or in a schedule referred to in this clause.)

6. Defense Industrial Plant Equipment Center (DIPEC).

Address: Defense Industrial Plant Equipment Center, Airways Blvd, Memphis, TN 38114. DIPEC provides two potential sources of equipment to both initially equip Army Skill Development Programs as well as provide a continuing source of equipment for ongoing vocational programs both in CONUS and overseas—Industrial Plant Equipment (IPE) from the Defense Industrial Reserve and Contractor excess property reported under the Contractor Inventory Redistribution System (CIRS).

a. Industrial Plant Equipment. (IPE). IPE is DOD-owned industrial plant equipment and is available to DOD components (PL 932–155, November 16, 1973 and AR 7002–43). Equipment is listed in separate handbooks, e.g., *Motor Vehicle Maintenance and Repair Shop.* These are available to ESOs (see app A). Requisition of equipment will be accomplished by use of DD Form 1419 (DOD Industrial Plant Equipment Requisition). Policies and procedures for preparation and submission of DD Form 1419 are contained in Appendix 3A, AR 7002–43. DD Form 1419 is available through normal AG publication channels. Handling, crating, and transportation of DIPEC IPE from place of storage to the Army Education Center (AEC) is borne by the Defense Logistic Agency (DLA). DIPEC IPE will not be included in TDA. Property Book accountability will be maintained on a separate Property Book page in a separate section at the end of the Property Book and will be annotated as "DIPEC Issued Equipment" —data may include condition and disposition. Equipment NO LONGER NEEDED in the Skill Development Program is considered "IDLE" and will be reported to DIPEC for final disposition on DD Form 1342 (DOD Property Record). DD Form 1342 is available through normal AG publications channels. Policies and procedures for preparation and submission of DD Form 1342 are contained in Appendix 2B, AR 7002–43.

b. Contractor Inventory Redistribution System (CIRS). CIRS' equipment is DOD-owned property (other than IPE) in possession of contractors which has been determined to be in excess of amount needed to complete performance of contract and has a high potential reuse. Included in this property are common hardware items, tools, purchased parts, office equipment, etc. ESOs should request their AEC be placed on the mailing list of the weekly CIRS' bulletin. Address: Commander, Defense Industrial Plant Equipment Center, ATTN: DIPEC–TEC, Memphis, TN 38114. Transportation costs will be borne by the requisitioning agency as prescribed in paragraph 5 of the Requisitioning Procedures (app B). CIRS' equipment will not be included in TDA nor returned to DIPEC—final disposition of the equipment will be in accordance with existing excess property procedures. Property Book accountability will be maintained in the same manner as DIPEC IPE and the Property Book page will be annotated as "CIRS' Issued Equipment."

7. DOD Declared Excess Personal Property.

Under the provisions of AR 7552–1 and AR 7552–2, DOD excess equipment may be obtained at no cost to the DOD component except crating and transportation charges from point of storage to the AEC requisitioning the equipment. Equipment may be obtained through either the Excess Personal Property Listing (EPPL) or the Interrogation Requirements Information System (IRIS).

a. Excess Personal Property Listing (EPPL).

(1) ESOs should request their AEC be placed on the mailing list of the EPPL issued by the Defense Property Disposal Service. Address: Commander, Defense Property Disposal Service, ATTN: DPDS–URS, Federal Center, Battle Creek, MI 49016.

(2) Requisitioning of equipment will be accomplished by the use of DD Form 13482–1 (DOD Single Line Item Requisitioning System Document). Preparation and submission of DD Form 13482–1 will be in accordance with MILSTRIP (DOD 4140.172–M, Military Standard Requisitioning and Issue Procedures). Requisition instructions are noted in each copy of the EPPL.

b. Interrogation Requirements Information System (IRIS).

(1) This is a computerized system that monitors excess property worldwide.

(2) Equipment is not listed in bulletins such as the EPPL; however, requests to determine whether specific pieces of equipment are in the system and available may be obtained within a 24 hour time frame by phone: AUTOVON 3692–6695 between the hours of 07452–1630 (EST — Battle Creek, MI). The National Stock Number (NSN) must be provided for each piece of equipment (see Army Supply Bulletin, SB 7002–20 for all NSNs).

(3) Requisitioning procedures are outlined in paragraph 1, Chapter VIII, DOD 4160.212–M (Defense Disposal Manual).

(4) ESOs may obtain further information concerning this source of acquiring equipment by contacting the Defense Property Disposal Service. (See para 2*a*(1) above.)

c. DOD excess property equipment will not be included in TDA. Property Book accountability will be maintained in the same manner as DIPEC IPE and the Property Book page will be annotated as "DOD Excess Property Issued Equipment."

d. Final Disposition of Equipment. Final disposition of the equipment will be in accordance with existing excess property procedures outlined in DOD 4160.212–M.

8. Loan or Redistribution from Units on the Installation.

a. Loan transaction is accomplished by a Hand Receipt (DA Form 2062). Loaned equipment will remain on the

accountable property records of the lending activity. Only "Redistributed Items" will be included in the TDA of the activity supporting the AEC.

b. Temporary loan may be made for two 180 day periods. (See sec 1, app H, AR 3102–34 for procedures.)

9. TDA Documentation.

a. Equipment that cannot be acquired through the sources outlined in this Section may be obtained through the procedures prescribed in appendix E, AR 3102–34 (Basis of Issue Guide for Documentation of Certain Equipment Items in TDA/JTA).

b. This Basis of Issue Guide includes equipment which has been determined necessary for instructional purposes in Skill Development course program

c. Requests for additional quantities of equipment over and above the current prescribed allowances (app E, AR 3102–34) for which a recurring need has been determined will be submitted in accordance with procedures prescribed in appendix H, AR 3102–34. The Letter Request will contain a paragraph stating that the equipment requirement for the specific piece(s) of equipment could not be satisfied through the acquisition sources listed in this section. The Letter Request for HQDA controlled items will be forwarded through command channels to HQDA (DAAG–EDS) WASH DC 20314 who in turn will forward the request to HQDA (DALO–PLF) for approval.

d. Request for commercial equipment costing $1,000 or more not listed in either appendix E, AR 3102–34 or chapter 6, SB 7002–20 will be submitted in accordance with procedures prescribed in paragraph 2–20, AR 3102–34. Requests for such equipment will be forwarded through command channels to HQDA (DAAG–EDS) WASH DC 20314 who will in turn forward the request to Headquarters, US Army Equipment Authorizations Review Activity for type classification exemption.

e. The Letter Request will contain a copy of DD Form 1419 and a statement from Defense Property Disposal Service stating that the requested equipment is not available through these sources.

f. Commands and agencies with requirements should identify them within the Planning. Programing and Budget (PBB) System for acquisition of this equipment.

10. Element of Expense.

a. Acquisition of non-PA (Procurement Appropriation) equipment, through Letter Request (paragraph 9c, above), costs associated with handling, crating, transportation of equipment, and maintenance of equipment will be charged against element of expense 3100 for 879732.2 (Skill Development).

b. After exhaustion of sources described in this section, hand tools required for implementation of course programs, e.g., hammers, pliers, screw-drivers, etc., may be obtained through Army supply channels in accordance with procedures outlined in CTA 50–970. Cost of this equipment will be charged against element of expense 3100 for 879732.2 (Skill Development).

Section III
IMPLEMENTATION OF COURSE PROGRAMS

11. Guidelines.

Suggested guidelines are provided to assist in the development and implementation of certain on-post vocational/technical course programs. These guidelines are based on a class size of 16–20 students and include performance objectives, suggested facility sizes, course content, and lists of major and minor equipment needs for the following course programs: Automotive Technology (app C), Diesel Technology (app D), Welding Technology (app E), Electronics Technology (app F), and Construction Technology (app G). These guidelines may also be used as evaluation criteria to assist in the selection of an accredited institution bidding on a solicitation to instruct in the vocational/technical course programs. (See para 5*b*, above.) (These are suggested guidelines only and are supplied through the courtesy of the Trade and Industrial Education Division of Vocational Education, Ohio State Department of Education.)

12. Additional Information.

Questions concerning the acquisition and accountability of the equipment and the implementation of the Army Skill Development Programs should be directed to HQDA (DAAG–EDS) WASH DC 20314.

Appendix A
INDEX OF INDUSTRIAL PLANT EQUIPMENT HANDBOOKS

A–1. Index of Industrial Plant Equipment Handbooks

The following table shows the available Industrial Plant Equipment Handbooks.

Table A–1
Index of Industrial Plant Equipment Handbooks

Army	Title
SB 708–3220–1	Woodworking Machines
SB 708–3400–2	Rolling Mills, Drawing Machines, and Metal Finishing Equipment
SB 708–3400–3	Portable Machine Tools, Metalworking Machinery Accessories, and Precision Layout Tools
SB 708–3400–4	Welding, Heat Cutting, and Metalizing Equipment
SB 708–3400–5	Machining Centers, Way Type Machines, Electrical and Ultrasonic Erosion Machines
SB 708–3400–6	Miscellaneous Machine Tools
SB 708–3400–7	Boring Machines, Broaching Machines, Gear Cutting and Finishing Machines
SB 708–3400–8	Secondary Metal Forming and Cutting Machines
SB 708–3405–1	Metalworking Saws and Filing Machines
SB 708–3413–1	Drilling and Tapping Machines
SB 708–3415–1	Grinding Machines
SB 708–3416–1	Metalworking Lathes
SB 708–3417–1	Milling Machines
SB 708–3418–1	Planers and Shapers (Includes Shapers, Formerly Part of FSC 3419)
SB 708–3500–1	Textile Industries Machinery and Industrial Sewing Machines
SB 708–3600–1	Pulp and Paper Industries and Size Reduction Machinery
SB 708–3600–2	Marking, Metal Container, Assembly, Clean Work Stations, and Miscellaneous Industry Machinery
SB 708–3620–1	Rubber and Plastics Working Machinery
SB 708–3635–1	Crystal and Glass Industries Machinery
SB 708–3650–1	Chemical and Pharmaceutical Products Manufacturing Machinery
SB 708–3670–1	Specialized Semiconductor, Microelectronic Circuit Board Manufacturing Machinery
SB 708–3680–1	Foundry Equipment
SB 708–4330–1	Centrifugals, Separators, and Filters
SB 708–4430–1	Industrial Furnaces, Ovens, and Heat Treating Equipment
SB 708–4440–1	Driers, Dehydrators, and Anhydrators
SB 708–4900–1	Specialized Ammunition and Ordnance Machinery
SB 708–4910–1	Motor Vehicle Maintenance and Repair Shop Specialized Equipment
SB 708–4920–1	Aircraft Maintenance and Repair Shop Specialized Equipment
SB 708–4940–1	Miscellaneous Maintenance and Repair Shop Specialized Equipment
SB 708–5860–1	Stimulated Coherent Radiation Devices (Lasers)
SB 708–6600–1	Liquid and Gas Flow, Pressure, Temperature, Humidity,and Mechanical Motion Measuring, and Controlling Instruments.
SB 708–6600–2	Scales, Balances, and Optical Instruments
SB 708–6600–3	Chemical Analysis and Laboratory Instruments
SB 708–6625–1	Electrical and Electronic Properties Measuring and Testing Instruments
SB 708–6635–1	Physical Properties Testing Equipment
SB 708–6636–1	Environmental Chambers
SB 708–6695–1	Combination and Miscellaneous Instruments Including Dynamometers

A–2. Distribution for IPE Handbooks:

Commander
US Army AG Publications Center
1655 Woodson Road
St. Louis, Missouri 63114

Appendix B
CONTRACTOR INVENTORY REDISTRIBUTION SCREENING LIST

B–1. Instructions for Using Lists

a. The Contractor Inventory Redistribution System (CIRS) produces several types of screening lists. The print format on all listing is the same for each page.

b. Each page is printed with a three-line heading. Information for individual line items is distinguished by dotted line separators. Data on the first print line within the separators corresponds to element names on the first print line of the heading. The second and third line within the separators corresponds to the second and third line of the heading. Additional descriptive data is continued on lines four and five. If available, the end item application will be printed on the last line. For example, NSN is shown as the first element on the top line of the heading and the actual stock number of the line item is printed directly below "NSN" as the first number on the first print line between the line separators. If an NSN is not available, then only the Federal Supply Class will be printed in this position.

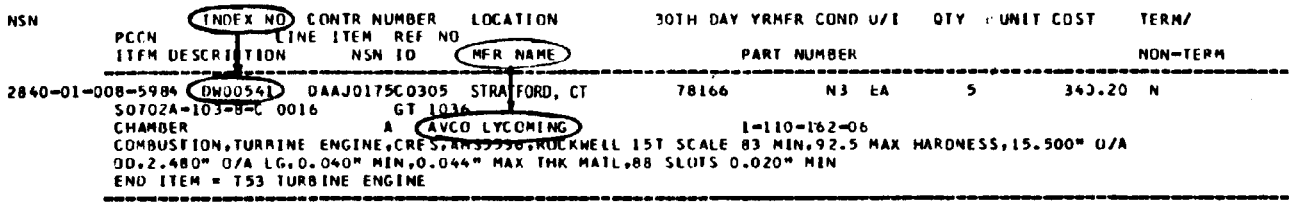

Figure B–1. Print-out from the Contractor Inventory Redistribution Screening List

B–2. Screening Periods

a. First through 30th Day: DoD-wide screening is performed. Procuring/requiring department retention priorities within this period are established by ASPR 242–205.2.

b. 31st through 60th Day: Screening is expanded to include other Federal agencies. Prior to the 61st day, DoD activities have priority over other Federal agencies.

c. 61st through 75th Day: During this period, requests from any agency will be honored on a "first come-first served" basis.

d. 76th through 90th Day: This screening period is for donation purposes outside the Federal Government.

Note. **IMPORTANT:** The 30th day of the screening cycle is shown on the screening list. This date indicates the last day of the Military Priority (owning service priority). DoD screening does not cease on this date but continues through the entire disposal process until such time as final disposal action is accomplished. Assets on which the 30th day has expired may still be available for redistribution. Inquiries concerning availability of these assets should be made immediately to DIPEC–SSC.

B–3. Requisitioning Procedures

a. Inquiries regarding availability of property listed herein may be directed to DIPEC by requisition or telephone. Use either ROUTING IDENTIFIER CODE "S9Q", mail address, DIPEC–SSC, MEMPHIS, TN 38114, or telephone AUTOVON 9662–9582 or 901/7442–5582. Telephone inquiries are suggested due to short screening cycles. Before calling, have available the CIRS INDEX NUMBER and your REQUISITION NUMBER. Upon receipt of a telephone inquiry, DIPEC will determine the availability of property and advise the requesting activity the status of the property. If all requisitioning information is relayed at the time of the inquiry, then confirmation copies are not required and should not be forwarded.

b. One of several media documents may be used to requisition property. They are: DD FORM 1348, DoD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT (MANUAL); DD FORM 1348M, DoD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT(MECHANICAL); DD FORM 173, MESSAGEFORM (SINGLE or MULTIPLE MESSAGE REQUISITIONS); or a DD FORM 1149, REQUISITION AND INVOICE/SHIPMENT DOCUMENT.

c. The CIRS INDEX NUMBER must be used to identify property on all CIRS requisitions submitted to DIPEC. On MILSTRIP "AOD" documents the INDEX NUMBER will be placed in CARD COLUMNS 8–14, and on MILSTRIP "AOE" it will be placed in the "REMARKS" field. Remaining data on MILSTRIP documents will be prepared in accordance with CHAPTER 2 of DoD MANUAL 4140.17M.

Note. Funds data on PCH&T must be pre-positioned at DIPEC in order to use DIC–AOD.

d. If the DD FORM 1149 is used, submit an original and one copy to DIPEC–SSC with individually assigned requisition/document number for each line item requisitioned. Requisitioned property need only be identified by the CIRS Index Number in Block 4b.

e. Funds citations will be entered as "REMARKS" on MILSTRIP documents (DIC–AOE) or entered in BLOCK 4 on the DD FORM 1149. Each line item entry listed herein is designated as "NON-TERMINATION INVENTORY" (N) or "TERMINATION INVENTORY" (T). When line item is coded "N", a citation for packing, crating, preparation for shipment, loading and transportation will be entered. Funds for transportation only will be cited when item entries are coded "T".

B–4. Distribution of Lists

Correct mailing addresses are essential to expedite distribution of lists to appropriate screening activities. Notification of change in distribution quantity of lists or address information should be furnished to: COMMANDER, DEFENSE INDUSTRIAL PLANT EQUIPMENT CENTER, ATTN: DIPEC–TEC, MEMPHIS, TN 38114.

Appendix C
AUTOMOTIVE TECHNOLOGY

C–1. Course Objectives:

a. The laboratory and related instruction will be based upon an occupational analysis which includes the skills, attitudes, and knowledge required to achieve the instructional objectives for the program. The basic principles of science and mathematics, with strong emphasis upon safety instruction, are integrated into the instructional units.

b. To provide information, theory, facts, and basic principles in the following major areas:

(1) *Basic Shop Principles and Practices.*

Safety Practices
Hand tools
Fittings and fasteners
Interpretation of manuals, charts, diagrams and specifications

(2) *Engines.*

Engine operation
Head, cylinder block
Valves and valve mechanisms
Piston and connecting rod assembly
Crankshaft and bearings
Lubrication systems, oil pump and filter
Cooling systems
Exhaust systems

(3) *Fuel Systems.*

Fuels
Carburetors
Fuel pumps
Intake manifolds and induction systems

(4) *Electrical.*

Diagnosis of electrical circuit malfunctions
Starter system
Ignition system
Charging system — A.C., D.C.
Lighting and warning systems
Battery and electric power distribution

(5) *Emission Systems.*

Fundamentals of emission control
Crankcase ventilation

Exhaust emission
Vapor control systems

(6) *Engine System Analysis and Repair.*

Use and interpretation of engine testing devices
Ignition systems
Fuel systems
Emission systems
Engine mechanical systems

(7) *Drive Line and Components.*

Gears, bearings and seals
Standard transmissions and clutches
Overdrive units
Automatic transmissions and control circuits
Drive Lines and Universals
Differentials and final drive units

(8) *Suspension, Steering and Braking.*

Suspension
Alignment
Steering
Springs
Wheels and tires
Braking systems
Chassis lubrication

(9) *Accessories.*

Heaters
Air conditioning
Automatic temperature control
Automatic seats
Speed controls
Automatic windows
Windshield wiper and washer systems

(10) *Shop Management and Control.*

Service diagnosis
Job pricing and estimating
Repair order writing
Service routing and management

C–2. Performance Objectives:

a. As a result of the instruction and supervised practice the student will:

(1) Be able to perform operations which show a basic understanding of the diagnostic and repair procedures in the automotive mechanic occupations and be capable of actual on-the-vehicle use of industrial testing and servicing equipment.

(2) Demonstrate the ability to service and repair brakes, steering, suspension, cooling, electrical, fuel, transmission, and engine systems of the automobile with the entry level standards of the automotive mechanic occupation.

(3) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

(4) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

(5) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude, and an appreciation of craftsmanship as needed for successful employment in the automotive mechanics trade.

(6) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(7) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the automotive mechanics trade.

(8) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods, and procedures of operation will be performed in the following major areas:

(1) *Basic Automotive Practices.* Identification of major automobile parts:

Engine
Brakes
Front end
Fuel system
Emission
Charging and Starting systems
Air conditioning

(2) *Engines.* Inspection and repair or replacement of:

Pistons and connecting rods, valve train, cylinder heads and cylinder block
Valve stems and guides, bearings and journals and pistons and cylinders
Service valves and valve seats, bearings, pistons and rings, connecting rods and cylinder walls
Use of precision gauges and indicators

(3) *Fuel Systems.* Inspection, adjustment, repair of:

Carburetor circuits
Float settings
Fuel/air ratio
High and low idle

(4) *Electrical.* Inspection, adjustment, repair of:

Electrical components
Electrical malfunctions
Ignition timing
Use test, instruments and equipment

(5) *Batteries.* Inspection and service of:

Inspection for condition
Testing for charge with hydrometer
Performing battery capacity test (BST)
Charging battery according to specification

(6) *Charging Systems.* Diagnosis, repair and service of:

Test instruments and equipment
Test and servicing alternator and components
Test and servicing regulator
Inspect charging system

(7) *Emission Systems.*

Identification of the correct emission system for the year in which the automobile was manufactured.
Diagnosis and test emission system components
Use of emission tests equipment
Inspecting emission system for proper installation

(8) *Engine Analysis and Repair.*

Utilization of test instruments and equipment
Inspection of engine and accessories for wear and damage
Interpretation of oscilloscope patterns
Detection and correction of engine malfunctions

(9) *Drive Lines and Components.*

Determination of end-play and backlash with dial indicator
Interpretation of gear tooth patterns
Checking and adjusting automatic transmission
Checking and adjusting hypoid differential

(10) *Suspension and Steering.*

Preparation of automobile (on rack) for alignment
Measurement of camber, caster and toe-in
Making alignment adjustments
Checking steering wheel to see that it is centered.

(11) *Brakes.*

Inspection and repair of cylinder bore and rotor
Overhauling piston assembly
Overhauling caliper assembly
Torque caliper to spindle and wheel bearings

(12) *Air Conditioning.*

Using air conditioning testing gauges and equipment
Bleeding gauges and identify state of charge
Following manufacturer's charging procedures
Test system for leaks

C–3. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	5,200 square feet
Tool room	200 square feet
Storage	230 square feet
Conference	120 square feet
Restroom and lockers	250 square feet
Total	6,000 square feet

C–4. Facility Considerations:

1. Two overhead power operated doors with safety stops 12′ × 12′. Personnel doors beside overhead (drive through design).
2. Room for 12 cars, angular stalls, 60° slant from walls, 11′ minimum width of stalls, 15′ minimum width of stalls with hoist.
3. One stall located by overhead door to have wall 5′ high separating it from other areas. This stall to have hot and cold water with separate drain to keep mud and water in stall.
4. Pull down, reel-type light at each stall (overhead electrical outlets).
5. Electricity (110 volt) and compressed air at each stall (36″ from floor).
6. Three twin-post lifts.
7. One frame contact lift.
8. Water available at each lift and at each wall of shop.
9. Lifts and wheel alignment stalls all located on one side of lab area near overhead door.
10. Floor exhaust system, flexible metal pipe to each of the 12 car stalls.
11. Floor exhaust system, in engine area, 12 flexible metal pipes.
12. 48 lockers—built-in, 12″ × 12″ × 72″.
13. 48 lockers—built-in, 14″ × 14″ × 28″ (tool box storage).
14. Wash-up sink, foot operated (12 students at a time).
15. Outside storage for ten to twelve cars fenced in with fence which would limit the view of the cars (10′ high with 12′ wide lockable gate).
16. Two caged storage units. One 150 square feet, one 200 square feet. (One will store equipment, other will be parts room with instructor desk with telephone service.) Area should have counter top front, pull-down cage front with locks (optional).

C–5. Course Content

I. General Service Work
II. Minor and Major Engine Repair
III. Cooling System Repair
IV. Diagnosing, Testing, and Repairing of the Various Components of the Electrical System
V. Minor and Major Fuel and Exhaust System Repair
VI. Testing and Servicing of Emission Systems
VII. Both Minor and Major Power Train Repair
VIII. Repair and Alignment of Suspension Systems
IX. Checking and Servicing the Steering System
X. Minor and Major Repairs on the Brake System
XI. Repairing and Servicing the Ventilating System
XII. Repairing Automobile Accessories

C–6. Major Equipment List: (15–20 Student Class Size)

11 Service benches for stalls—28″ × 60″ × 34″ high with vise
2 Engine repair benches
1 Wheel aligner
4 Engine stands (overhaul)
1 Alternator and generator tester
1 Drill press — pedestal
1 Wheel balancer, complete
1 Distributor tester, complete
1 Lathe (brake and drum)
1 Brake shoe grinder
1 Valve equipment
1 Air compressor —120 gallon tank, 10 hp.
3 Hydraulic lifts — twin post
16 Cordomatic lights hung from overhead
1 Spark plug service machine
1 Engine analyzer, complete
1 Tool cabinet
12 Engine stand (with motor)
1 Parts cleaning machine
1 Hydraulic arbor press
2 Filing cabinets
1 Crane, hydraulic, 1 ton, with attachments
20 Creepers, Dippsy-Doodle center
2 Drills, electric ¼″ H.D.
2 Drills, electric ½″ H.D.
1 Battery charger
1 Armature lathe
2 Grinders, bench, 1 grinding wheel and 1 wire wheel with safety guards, single phase 1750 r.p.m.
2 Jacks, floor, 2 ton roll under long chassis
1 Jack, bumper, 1½ ton hydraulic
1 Jack, transmission, lift–type, hydraulic
2 Jacks, transmission, floor type, hydraulic with all make adaptors
2 Wrenches, impact: air ½″ drive with sockets
1 Welder, acetylene: unit with gauges, hoses, welding torch with tips; welding goggles; cutting attachments with tips
1 Cart for acetylene tanks
20 Pair stands — five ton
1 Bin, parts for tool room, 36″ × 85″ × 12″ deep (39 bins with 18 drawers)
1 Cabinet — combination type 36″ wide, 21″ deep, 78″ high
15 Couplers, quick, for air hose
15 Connectors, quick couplers, ¼″ male use
15 Connectors, quick couplers, ¼″ female use
15 Hose, air, 5 ply, 25 feet with couplings
2 Suction guns
2 Steel storage cabinets —36″ × 18″ × 78″ with swinging doors

52 Lockers for tool boxes
11 4″ machinist vises
Lubrication equipment
Armature tester
Tire changer
Part tank “hot”

C–7. Minor Equipment List

Feeder covers
Seat covers
Headlight aimer
Creeper seats
Timing lights
Air chisel
Micrometers
Drill bits
Torque wrenches
Puller set
Brake cylinder hone
Ridge reamer
Cylinder bones
Valve lifter
Oil pressure test gauge
Fuel pressure test gauge
Vacuum gauge
Fire extinguisher
Armature growler
Hacksaws
Tack/dwell meters
Cooling system pressure tester
Soldering irons
Hydrometers
Funnels
Exhaust hose
Carburetor tool kits
Ring compressors
Double lap flare tool
Nut cracker
Tail pipe expander
Various hammers
Brake bleeder
Fuel filter wrench
Oil filter wrench
Drain pans
Caster–camber wrench set
Tie rod spreaders
Oily waste cans
Safety cans
Air impact wrench
Automotive tap and die set
Water hose
Floor squeegees
Grinding wheel dresser
Mops
Brooms
Bench brooms
Bead expander
Battery carrier
Battery terminal brush
Battery cable booster

Battery cable puller
Calipers
Chisels
C-clamps 3″ and 6″
Center punch
Carbon scrapers
Can spouts
Extension cords
Volt meters
Battery cell probes
Compression testers
Volt-amp tester
Clutch aligning set
Oil measure, 2 quarts
Pipe wrench 14″
Pump oilers
Pin punch set
Pliers set
Nut driver set
Piston ring installer
Putty knives
Screw extension set
Tin snips
Tube cutter
Tube benders
Vise grips
Soft faced hammers
Screwdriver sets
Files
Various sets of hand tools for the tool room, such as:
  Open end wrenches
  Combination wrenches
  Ratchet wrenches
  Ratchet set with various sizes and drives
  10″ adjustable wrenches
  15″ adjustable wrenches

Appendix D
DIESEL TECHNOLOGY

D–1. Course Objectives:

a. The shop and related instruction shall be based upon an occupational analysis which includes the skills, attitudes, and technical knowledge required to achieve the instructional objectives for the program. The basic principles of mathematics and science, with strong emphasis on safety instruction, are integrated into the diesel engine instructional units.

b. To provide trade information, theory, facts, and basic principles in the following major areas of diesel engine mechanics:

(1) *Fuel Injection Pumps and Nozzles Repair and Adjustment*

(a) Principles of operation of the eight basic fuel injection systems which consist of the following:

Robert Bosch
American Bosch (in–line and distributor types)
CAV (in–line and distributor types)
Simms
GMC
Cummins
Caterpillar
Roosa master (DC, DB, and C models)

(b) Principles of the operation of the above pump systems
(c) Principles of the operation of injection nozzles
(d) Principles of the operation of Centrifugal and hydraulic governors

(2) *Electrical Systems Diagnosis and Repair.*

(a) Basic electrical theory and its application to electricity
(b) Principles of dc generator operation and function
(c) Principles of ac generator operation and function
(d) Function and principle of operation of the ignition system
(e) Principles and operation of starting systems
(f) Principles and operation of pre-heat systems
(g) Principles and operation of accessory systems
(h) Applicant should be familiar with the current diagnosis and repair procedures for all electrical systems

(3) *Hydraulic Systems Troubleshooting and Repair.*

(a) Basic principles, Pascal's Law, Bernelle's principle, and etc.
(b) Principles of operation of pumps
(c) Principles of control valves; pressure, flow, directional principles of troubleshooting
(d) Function of reservoirs and accessories
(e) Function of actuators; cylinders, and motors, principles of operation, testing procedures
(f) Principles and operation of basic air devices

(4) *Basic Engine Diagnosis and Repair.* Principles and functions of:

Troubleshooting; diagnostic methods for determining engine problems and needed repairs
Valve area; current methods of refinishing of valve faces, valve seats, and valve guides
Cylinder area; proper measurement and methods of repairing or replacing
Crankshaft; methods of checking clearances, and determining need for replacement of units
Disassembly and assembly procedures to ensure a proper performance of the completed engine
Adjustments and minor tune-up to be performed on all engines after final assembly

(5) *Power Train Operation and Repair.*

Principles of clutch operation and methods of adjustment
Standard transmission operation and methods of diagnosis
Power shift transmission troubleshooting
Ring gear and pinion function and adjustment
Operation of final reduction drives including planetary and bull gear types
Principles of PTO power units including mechanical and hydraulic operated
Principles of brake operation of both mechanical and hydraulic types

D–2. Performance Objectives:

a. As a result of the instruction and supervised practice the student will:

(1) Be able to perform operations which show a basic understanding of the diagnostic and repair procedures in diesel engine repair occupations, and be capable of actual on–the–vehicle use of industrial testing and servicing equipment. Demonstrate the ability to service and repair fuel systems and their components, air compressor, superchargers, starting systems and electrical systems with acceptable entry level standards of the diesel repair occupation.

(2) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness and habits of safe practice.

(3) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

(4) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(5) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude, and an appreciation of craftsmanship; as needed for successful employment in the diesel mechanic trade.

(6) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the diesel mechanic trade.

(7) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods, and procedures of operation will be performed in the following major areas:

(1) *Fuel Injection Pumps and Nozzles Repair and Adjustment.* Paragraph not used.

(2) *Testing and Calibrating Pump Systems.*

Testing and calibrating injection nozzles
Servicing centrifugal and hydraulic governors

(3) *Electrical Systems Diagnosis and Repair.*

Generator and alternator performance
Generator and alternator repairs

(4) *Hydraulic Systems Troubleshooting and Repair.*

Troubleshooting and repair of control valves
Operating, testing and repair of actuators
Repair of basic air devices

(5) *Basic Engine Diagnosis and Repair.*

Adjustments and minor tune-up on engines
Current methods of refinishing valve faces, valve seats, and valve guides
Repair of cylinder area
Servicing crank shafts
Troubleshooting, diagnostic procedures for determining engine problems

(6) *Power Train Operation and Repair.*

Power shift transmission repair
Methods of clutch adjustments
Standard transmission repair
Hydraulic and mechanical brake repair
Repair of clutches
Repair and service of PTO power units
Service to ring gears and pinions

D–3. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	5,500 square feet
Tool room	150 square feet
Storage	120 square feet
Conference	250 square feet
Restroom and lockers	250 square feet
White room	250 Square Feet
Total	6,470 square feet

D–4. Facility Considerations for General Contract:

1. Drinking fountain
2. Concrete floors sloped to center drains
3. Overhead fume exhaust system ½
4. Under floor exhaust system ½
5. Two overhead power operated doors, twenty feet wide
6. High ceiling shop
7. Personnel door
8. Service road access
9. Twenty foot concrete apron outside overhead doors
10. Overhead I-beam trolley chain hoist, 3 ton
11. Compressed air at each stall with local adjustable pressure regulator and all extractors with 02–150 PSI gauges
12. Water at each overhead door, inside and out
13. Water available on each interior wall
14. Grounded duplex wall outlet—110V at each stall
15. One lift, 1—1½—2 on short and long wheel base trucks, heavy duty—2 column (fore and aft type) suitable for lifting
16. Pit for inspection with removable pipe safety fence
17. Chalk and bulletin boards
18. Sound absorption materials used wherever possible
19. Locate lab close to auto mechanic and agriculture mechanic in heavy shop area
20. Welder electrical outlet
21. Roof vent with wall switch (high volume) 2–speed fan control
22. Underground oil waste disposal
23. 110V–209V–220V electricity available
24. Electric shut-off switches, lock type
25. Dutch doors in tool room
26. Clean up area with fifty lockers

D–5. Tool Room

1 Industrial puller set
1 Farm tractor puller set
1 1″ Socket set (1⅝″–3½″)
1 ¾″ Socket set (⅞″–2⅜″)
1 ½″ Deep socket set (⅜″–⅞″)
1 Allen set (⅛″–⅝″)
1 Tap and die set NC
1 Tap and die set NF
1 Pipe tap set (⅛″–¾″)
1 Pilot reamer set (½″–1¼″)
1 Cylinder hone, rigid
1 Universal sleeve puller set (less sleeve adapter plates)
1 Cylinder ridge reamer
1 Thread chaser
1 Electric drill (½″)
2 Electric drills (¼″)
1 Set drill bits (1/16″–½″)

1 Screw extractor set
1 Copper tubing service kit
1 Oil leakage detector
1 Oil leakage detector
1 Hydraulic jack (3–ton)
1 Hydraulic jack (20–ton)
1 Straight edge (4′)
1 Volume grease dispenser
1 High pressure grease gun
1 Gear oil dispenser
1 Antifreeze tester
1 Battery hydrometer
4 Creepers (floor)
8 Light drop cords (25′) (extension)
1 Sledge hammer
2 Cummins timing fixtures
4 Plastic hammers
4 Piston ring compressors
2 Hacksaws
1 Carburetor tool kit
1 Soldering gun kit
1 Carpenter square
1 Combination square
1 Set box end and open end wrenches (¼″–2″)
1 Set box end and open end wrenches (metric)
1 set metric socket wrenches
1 Injector tube installation kit
1 Detroit blower service kit
1 Hydraulic flo-rater
1 Battery service kit
1 Bushing universal installation tool
6 Wire brushes
6 Carbon scrapers
1 Photo tachometer
1 Radiator pressure tester
1 Magnetic crack detector
1 Water pressure crack detector
1 Universal precup puller set
1 Adjustable wrench (20″)
2 Torque wrench (10–150 ft. lb.)
1 Torque wrench (100–500 ft. lb.)
1 Tin shears
2 Valve spring compressors
1 Micrometer set (0″–6″) with standards and case
4 Micrometers (0–1″)
4 Micrometers (1″–2″)
4 Micrometers (2″–3″)
2 Inside micrometer set (2″–8″)
2 Micrometer ball attachment
1 Universal dial test indicator set
1 Cylinder gauge (2 1/10″–6″)
1 Micrometer depth gauge (0–6″)
2 Oil measures (1 qt.)
2 Oil measures (I gal.)
1 Pipe wrench (24″)
1 Brake spring pliers
2 Battery carriers
2 Water buckets
2 Pairs, booster battery cables
2 Pry bars 23/32″ × 24″
2 Rolling head bars ″ × 18″

10 Screwdriver (assortment)
12 Files (assortment)
2 Compression tester
1 Leakage tester
2 Log chains (3/8″ × 25′)
1 Heli-coil kit
1 Stud remover 5/8″, 1″
1 Copper tubing service kit (3/16″, 5/8″)
1 Feeler gauge set
Miscellaneous Supplies:
Miscellaneous oil cans (hand)
Gasket material
Cotter pins (miscellaneous)
Washers
1 Fire extinguisher (20 lb.)
1 Flex stone set or glaze breaker
Miscellaneous drain pans and buckets

D–6. Fuel Injection Equipment Test and Mock-up Shop

Fuel injection test area:

2 Steel benches and cabinet combination (30″ × 6′)
4 wall benches (24″ × 36″)
8 Wall fitting and adapter cabinets (5′ × 4′ × 1′) glass fronts
4 Fuel injection test stands (miscellaneous fittings, adapters, and accessories)
1 Caterpillar fuel injection test stand (miscellaneous fittings, adapters, and special tools)
1 GM unit injector tester and accessories
1 Injector flow comparator
1 Diesel nozzle analyzer
1 Nozzle valve microscope
1 Nozzle valve lapping device and accessories
1 Ultrasonic cleaner
1 Nozzle high pressure cleaner
1 Torque vise
1 Concentricity gauge
2 Diesel nozzle testers
1 Set lapping blocks
1 Jar compound
2 Torque wrenches (5–600 inch–lbs.)
2 Torque wrenches (10–150 ft.–lbs.)
1 Compression tester
2 Fuel system analysis kit
8 Pump and nozzle (miscellaneous tool and service) kits
1 Universal dial test indicator set
1 Micrometer depth gauge (0″–6″)
2 Micrometers (0″–1″)
2 Micrometers (1″–2″)
Miscellaneous items
Temperature and dust control equipment
Supplies (calibrating oil, cleaning solvent, and janitorial supplies)
Fuel injection mock-up shop
5 Steel benches and cabinet combination (30″ × 6′)
5 Vises (4″)
30 Parts pans
1 Hand press (3–ton)
10 Steel racks (3 × 4, equipment)
1 small parts cleaner
1 Smokemeter (with stand)
6 Allen wrench sets (.028″–1/2″)
7 Air hoses and fittings

Miscellaneous cutaway and demonstration equipment
Training mockup components

D–7. Main Shop Area

15 Steel benches (30″ × 72″)
15 Vises (4″)
5 Parts racks (wood fabricated)
1 Portable floor jack (10-ton)
1 Portable floor jack (4-ton)
6 HD engine stands
2 PTO Dynamometers
4 Chasis Dynamometer
1 Hydraulic press (75-ton)
1 Hand press (3-ton)
1 Clutch pressure plate adjusting fixture
1 10″ Lathe and attachments
1 ⅜″ Drill press (bench)
1 ¾″ Drill press (floor)
1 Connecting rod alignment fixture and adapters
2 Valve grinders
2 Valve seat grinders
1 Air compressor (3 hp.)
Air hose and fittings
1 Small parts cleaners
1 Arc welder
1 Gas welding equipment (D.S.)
2 Pedestal grinders (10″)
1 Mobile floor crane (4,000 lbs.)
1 Valve spring tester
Exhaust ventilating system
3 Fire extinguishers (20 lb.)
4 Farm tractor jack stands
Supplies (cleaning solutions and janitorial supplies)
Miscellaneous engines and tractors

D–8. Basic Engine Classroom Shop Combination

1 Blackboard and equipment
1 Instructor desk and chair
20 Classroom chairs (tablet arm)
1 Overhead projector
1 Film strip projector
17 Steel benches (30″ × 6′)
10 Vises (4″)
1 Valve grinder
1 Valve seat grinder
1 Connecting rod aliner
1 Valve spring tester
1 Bench grinder (8″)
1 Small parts washer
1 Battery charger
6 Batteries (12 volt)
12 Engines
Air hose and fittings
2 Torque wrenches (200 ft. lbs.)
2 Torque wrenches (250 ft. lbs.)
2 Piston ring compressors
2 Valve spring compressors

Miscellaneous small tools

D–9. Dynamometer Room

Engine dynamometer (500 h.p.)
1 Engine dynamometer (700 h.p.)
2 Portable cooling columns
2 Engine stands (48″ × 104″)
1 Universal front engine mounts and adapter kit
1 Universal rear engine mounts and adapter kit
1 Engine cooling column interconnecting kit
1 Cooling column to engine adapter kit
2 Guard assemblies
8 Pedestals H.D.
2 Drive shafts H.D.
2 Farm tractor PTO drive shafts

D–10. Basic Electrical Classroom and Shop Combination

1 Blackboard and equipment
1 Overhead projector
1 Film strip projector
1 Instructor desk and chair
15 Tables (30″ × 6′)
20 Chairs (swivel)
4 Steel racks (demonstration equipment)
12 Steel benches (30″ × 6′)
6 Generator test stands (drives)
2 Engines
2 Engine stands
3 Distributor testers
5 Volt-ampere testers
2 Battery starter testers
1 Battery tester
5 Vises (4″)
1 Battery charger
1 Load bank
2 Armature testers
2 Ohmmeters
Miscellaneous jumper leads
6 Batteries (12 volt)
2 Generator field controls
4 Field rheostats
2 Pairs, battery booster cables
Miscellaneous tools
Electrical components (training)

D–11. Steam and Hot Tank Room

1 Steam cleaner
1 Hot tank and burner

D–12. Basic Hand Tool Set

1 toolbox
1 Socket set, ¼″ square drive, composition:
  1 ratchet
  9 Sockets, 6 pt., (3⁄16″ thru ½ m.)
  1 Flex t-handle
1 Socket set, ⅜″ square drive, composition:
  1 Ratchet

7 Sockets, 12 pt. (3/8″ thru 3/4″)
8 Sockets, deep well, 12 pt. (3/8″ thru 13/16″)
3 Extension bars, (3″, 6″, and 10″)
2 Socket adapters, (3/8″ to 1/4″ and 3/8″ and 3/8″ to 1/2″)
3 Screwdriver bits, (.030, .039, .055)
1 Socket set, 1/2″ square drive, composition
1 Ratchet
12 Sockets, 12 pt. (7/16″ thru 1 1/2″)
11 Deep sockets, 12 pt. (1/2″ thru 1 1/8″)
1 Spark plug socket (13/16″)
1 Flex t-handle
1 Universal joint
3 Extension bars (3″, 6″, and 10″)
1 Speeder (18″)
1 Slide bar
1 Cross bar
2 Flex t-handles (15″ and 18″)
2 Socket adapters (1/2″ to 3/8″ and 1/2″ to 3/4″)
3 Wrench sets, composition:
16 Combination wrenches (1/4″ thru 1 1/8″)
9 Open-end wrenches (1/4″ × 5/16″ thru 1 1/16″ × 1 1/8″)
11 Box end wrenches (1/4″ × 5/16″ thru 1 1/16″ × 1 1/4″)
3 Flare nut wrenches (3/8 × 7/16 thru 5/8 × 11/16)
Miscellaneous tools
3 Phillips screwdrivers (Nos. 1, 2, and 3)
1 Offset screwdriver
4 Standard screwdrivers (3/16 × 4, 1/4 × 6, 5/16 × 8 and Stubby)
1 Line–up punch (12″)
1 Punch and chisel set, 12 piece
6 Pliers, bent needle nose; battery pliers; diagonal/cutting pliers; slip joint pliers/hose clamp pliers; locking pliers 10″
1 Hex key set, 11 pieces
1 Hacksaw with 10 extra blades
2 Hammers, ball peen (16 oz. and 40 oz.)
1 Hammer, (8 12 oz.) no bounce, fiber tip
1 Rolling wedge bar (16″)
1 Stainless steel rule
1 Gasket scraper
1 Ignition tile
2 Files, half round (8″ and 10″)
1 File, round (6″)
1 File, mil (10″)
2 Feeler gauge, nonmagnetic (standard and long leaf)
1 Scratch awl
1 Flashlight (D size batteries)

D–13. Supplies

Fine, valve grinding compound
Six inch wire wheels, 5/8″ arbor
Sheet asbestos
Acid core solder (1 lb, rolls)
H.D. brake fluid
Oil dry
Anti-sieze compound
Permatex super 300 sealer, or equivalent
Ten pound cans wheel bearing grease
Five gallon cans carburetor cleaner
Spray silicone
Brazing flux
Rough service 100 watt light bulbs
Small propane tanks

Plastic electrician's tape
Aerosol penetrating oil
Fourteen gallon plastic covered wire
Assortment, wire terminals and solderless connectors
Shade 10 welding helmet lenses
Gasket material (two thicknesses)
Cover lens (helmet)
Plastigauge strips
Two-cell flashlights
Flashlight batteries
Flashlight bulbs
Copper tubing: ¼″, ⅜″, 5⁄16″
Steel tubing: ¼″, ⅜″, 5⁄16″

D–14. Course Content

I. General Service Work
II. Minor and Major Engine Repair
III. Minor and Major Fuel System Components Reconditioning
IV. Testing and Servicing Air Compressors, Super-Chargers and Turbo-Chargers
V. Repairing and Servicing Water Pumps
VI. Diagnostic Testing and Repair of Alternator Generator and Regulator, Starting Motor, Series Parallel Switcher, and Batteries

Appendix E
WELDING TECHNOLOGY

E–1. Welding Processes and Inspection—Course Objectives:

a. The laboratory and related instruction will be based upon an occupational analysis which includes skills, attitudes and knowledge required to achieve the instructional objectives for the program. The basic principles of science and mathematics with strong emphasis upon safety instruction are integrated into the instructional units.

b. To provide trade information, theory, facts, and basic principles in the following major areas:

(1) *Arc Welding.*

Basic knowledge of all arc welding processes
Basic material composition
Electrodes and gases
Electricity applicable to welding

(2) *Brazing.*

Heating methods
Brazing alloys
Use of torch on various materials
Gas cutting

(3) *Oxy-Acetylene.*

Complete set-up
Safety
Use of oxyacetylene on various metals

(4) *Resistance Welding.*

Different resistance processes
Basic principle of resistance processes
Process control

(5) *Other Welding Processes.*

Basic principle of ultrasonic and electron beam welding

Basic principle of solid state, thermit and laser welding
Safety applicable to above processes

(6) *Joint Design.*

Working knowledge of basic joints
Why a given design is used

(7) *Welding Symbols.*

Recognition
Application
Terminology

(8) *Procedure Qualifications.* Per section #9, ASME boiler and pressure vessel codes
(9) *Welders Qualifications* Per section #9, ASME boiler and pressure vessel codes
(10) *Weld Inspection and Defects.*

Working knowledge of possible defects
Cause of defects
Prevention of defects

E–2. Performance Objectives:

a. As a result of the instruction and supervised practice the student will:

(1) Demonstrate his ability to arc weld and oxy-acetylene weld structural shapes to meet the entry level standards for fracture and guided bend test.

(2) Demonstrate his ability in tungsten inert gas welding on ferrous and nonferrous metals as well as automatic and semiautomatic inert gas and fluxcored wire processes, to meet established entry level trade standards.

(3) Perform operations in hand burning, machine burning, and hard facing to meet the established entry level trade standards.

(4) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

(5) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

(6) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(7) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude and an appreciation of craftsmanship; as needed for successful employment in the welding trade.

(8) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the foundry trade.

(9) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods, and procedures of operation will be performed in the following major areas:

(1) *Shielded Metal Arc Welding.*

Set-up of material to be welded
Current and rod selection
Use of test equipment
Grinding and test equipment
Welds in the 3G, 2F, 3F, and 4F positions

(2) *Oxyacetylene Brazing.*

Set-up equipment
Preparation of material for brazing
Correct tip, flux, and filler rod selection
Brazing of dissimilar metals

E–3. Facility Specifications

Minimum Square Foot Requirements:

Laboratory . . . . . 4,000 square feet
Tool room . . . . . 100 square feet

Storage	120 square feet
Conference	120 square feet
Restroom and lockers	250 square feet
Manifold rooms (2)(8 × 10)	160 Square Feet
Total	4,750 square feet

E–4. Facility Considerations for General Contract:

a. Major emphasis should be placed on large, efficient exhaust system. Gas and oxygen should be on manifold system to tanks in separate 8 × 10 manifold rooms with outside entrance, explosion proof, side by side. The manifold rooms need to be heated and ventilated.

b. Twenty-four booths should be provided approximately 5′ wide and 6′ deep.

c. Booth partitions: The top of the booths should be hooded. Booths being open at the bottom make it easier to observe students, keep booths clean, and provides better ventilation to the booth.

d. Scrap storage hidden from view should be provided near outside door or outside.

e. Individual lighting should be provided over the work table in each booth.

f. Exhaust hood should be provided for the full length of the booth areas. There should be no windows directly over the booth areas. Fume removal must be from the hood and from bench level.

g. Water outlet and drains for tig machines.

h. Compressed air outlets need to be provided at every four booths.

i. Large ceiling exhaust fan to remove floor fumes.

j. Overhead buss ducts for are welders and other equipment.

k. Electrical considerations to handle 300 amp. welders—plus 100% expansion (very important). 1000 amp. main panel.

l. Outside wall outlets for welder located by overhead door on apron.

m. Dutch doors in tool room.

n. Power overhead service door 8–12 ft. wide, 12 ft. high.

o. Wash–up area.

p. Drinking fountain.

q. Fifty lockers in wash–up area.

E–5. Major Equipment List

Acetylene manifold system for 10 booths (complete)
Oxygen manifold system for 10 booths (complete)
Station regulators (gauge-oxygen)
Station regulators (gauge-acetylene)
Nonreturn station valves (oxygen)
Nonreturn station valves (acetylene)
Cutting attachments, complete
Welding hose, 8′ L
Weld torches
Welding tip assemblies, no. 1, No. 3, No. 5
Flame cutting machine (track type)
Abrasive metal cutting saw
50-ton hand hydraulic press
Power hacksaw
Anvils
Cylinder trucks
Set of gauges, hose, torch, and tips for trucks
Cabinet desk
20″ drill press
Hand, wheel type electric grinders H.D.
½″ electric drill H.D.
Extension cords H.D.
Fire blankets and cases
First aid kit
10″ pedestal grinders
7″ pedestal grinders Oily waste cans
Shop stools, 26″, without backs
Sections steel shelves 36″ × 12″ × 87″

Sections steel shelves 36″ × 18″ × 87″
Steel top work benches
H.D. bench vises
A.C.-D.C. welders 300 amp. H.D. transformer rectifier
Mig 300 amp H.D. with wire feeder controls gun and cable assemblies
Tig 300 amp. H.D. transformer rectifier ac dc with controls regulator, flow meter, torch and hose assembly
Spot welder

Note. Sufficient amount of ground cable, conductor cable, ground clamp lugs and 300 amp. electrode holders.

E–6. Minor Equipment List

Adjustable wrench, capacity 4″, 6″, 8″, 10″, 12″
Combination box and open end wrenches, same opening each end, open end angled 15° polished chrome mirror finish —11 wrenches
Rigid heavy duty pipe cutter, capacity ⅛″ to 1¼″
Rigid straight pipe wrench, length 10″ jaw opening 1½″
Rigid straight pipe wrench, length 12′ jaw opening 2″
Rigid pipe vise, capacity ⅛″ to 2 ½″
Adjustable dies
High speed drill set from 1/16″ to ½″ by 64ths, 29 drills unmounted
Micrometer, 0″ to 1″
Outside calipers, 8″
Inside calipers, 8″
Dividers, 8″
Tap and drill gauge
Combination square–12″
Center punches (round shank–knurled grip) 4″ long, ″ diameter top of tapered point, 9/32″ diameter of body
Center punches (round shank–knurled grip) 4″ long, 5/32″ diameter top of tapered point, ⅜″ diameter of body
Set of 8 drive pin punches, (1 of each size) in round wood box
Lupkin “Lokmatic” tape, 12′
Aluminum levels, 24″-4 vial
Square, polished body 24″ × 2″, tongue 16″ × 1½″
Cold chisels, ⅜″, ½″, ⅞″ cutting edge
Handy clamps, jaws open 3″
C clamps, 4″ opening 2 1/16″ depth
C clamps, 6″ opening, 2¾″ depth
C clamps, 8″ opening, 3¼″ depth
C clamps, 12″ opening 3⅝″ depth
Offset screwdriver, 4″ long, 3/32″ tip; 6″ long, 13/32″ tip
Pocket screwdriver
Screwdriver, 4″ blade, 7¾″ overall
Screwdriver, 6″ blade, 10¼″ overall
Screwdriver, 8″ blade, 13″ overall
Long chain needle nose pliers, w/cutters, 6″
Tongue-n-groove utility pliers, 10″ long, 1½″ capacity
Side cutting pliers, 6″
Combination pliers, 6″, 1″ capacity; 1¼″ capacity
Vise-grip wrenches, ⅝″ jaw thickness, 1½″ jaw adjustment
Porter bolt clippers or cutters, 24″ long, ⅜″ capacity
Ball peen hammers, 4 oz., 8 oz., 20 oz.
Rawhide mallets, 1¾″ diameter, 3¼″ long. 7½ oz.
Scratch awl, 6″
Oilstone, soft
Oilstone, hard
Hole saw—7 sizes of blades, 1″ to 2½″ in ¼″ graduations—fits ¼″ drill and over
Mill file, 8″ bastard
Mill file, 8″ second cut
Mill file, 8″ smooth
Mill file, 10″ bastard
Mill file, 10″ smooth

Hand file (double cut) 12″ second cut
Hand file (double cut) 12″ smooth
Three-square file, 8″ second cut
Three-square file, 8″ bastard
Three-square file, 8″ smooth
Square file, 8″ second cut
Square file, 8″ smooth
Engineers hammers, 40 oz.
Hand file (double cut) 12″ bastard
Vixen files, half round, 10″ fine
Needle files with round handles, 5 ½″
Vixen files, half round, 10″ standard
Vixen files, flat, 10″ standard
Vixen files, flat, 10″ fine
Vixen files, flat, 10″ smooth
Nicholson file card and brush, brush 1½″ × 5″, 9½″ long
Grinding wheel dresser, hooded Huntington dresser
Hand grinder (snag grinder)
Torque rated stanley industrial drill, ¼″ chuck size.
Heavy duty extension cord, 14–2, 50′
Pop starter kit
Leather half jackets
Goggles
High speed drill set from letter size A to Z, straight shank, 26 drill unmounted

E–7. Course Content

I. Oxy-Acetylene Welding and Cutting
II. Electric Arc Welding
III. Gas Metal Are Welding (Mig)
IV. Gas Tungsten Are Welding (Tig)
V. Resistance Welding

Appendix F
ELECTRONICS TECHNOLOGY

F–1. Course Objectives:

a. The classroom, laboratory, and practical learning experiences include the theory and practices concerned with construction, maintenance, and repair of electronic equipment used in industry. Included are vacuum tube and solid state circuitry, and devices and components used in power supplies, timers, welding equipment, sensors, electronic hearing, magnetics, rotating machinery, servos, and logic systems.

b. To provide information, facts, and the basic principles of the Electronic Industry in the following major areas:

(1) *Basic Electronic Fundamentals.* Basic physics involving atomic structure, conductor, insulator, semiconductor, electrical terms and units, fundamentals of magnetism — resistance circuits, Measuring devices, circuit analysis, sine wave characteristics, resonance amplifiers, and semiconductor fundamentals.

(2) *Digital Circuits.* Computer definitions, block diagrams, associated circuitry, computer circuitry, fundamentals of switching, number system, boolean algebra, electronic logic, sequential networks, and minimization methods.

(3) *Networks (Passive).* D–C circuit analysis, network theories and laws, inductance in series and parallel, impedance in R–L circuits, impedance in R–C circuits, resonance R–LC circuits, and gas tubes.

(4) *Components.* Capacitance—capacitors in series and parallel, transformers, vacuum tube fundamentals, triode vacuum tubes, tetrodes and pentodes, multigrid and special purpose tubes, integrated circuits, silicon controlled rectifiers, and photo electric devices.

(5) *Use of Instruments.* Measuring devices, meter movements, ammeter, ohmmeter, voltmeter, multimeter, cathode ray oscilloscope, sweep generators, market generators, digital voltmeters, and counters.

(6) *Troubleshooting.* Location and correction of malfunctions, replacement of component parts.

(7) *Electronic Assembly Precautions.* Reading of circuit diagrams, computations, and assembly relationships.

(8) *Amplifiers, Detectors and Active Circuits.* Test and analyze power supplies, amplifiers, transistor amplifiers, integrated circuits, transistor oscillators, basic oscillator circuits, R–F amplifiers, modulation and detection, non-sinosoidal waveshapes, relaxation oscillators, wave shaping circuits, industrial timer, industrial rectification and inversion, and electronic heating.

(9) *Computer Technology.* Programing, calculations, and conversion of numbers.

(10) *Transducers.* Utilization of strain gages, resistance thermometers, accelerometers, angle position indicators, anemometers, vacuum gages, and thermocouples.

(11) *Energy Conversion (Servoloops).* Application and use of magnetic amplifiers, saturable reactor, amplifier, self-exited magnetic amplifiers, motors and generators, control systems and synchros, welders, and electronic heating.

(12) *Electronic Control Devices.* Application and use of transistors, thyratrons, transistor circuit configuration, and characteristic curves.

F–2. Performance Objectives:

a. As a result of the instruction and supervised practice thestudent will:

(1) Demonstrate the understanding of the theory of electrical and electronics principles by reading schematic diagrams and interpreting tests to construct, fabricate and repair electronic equipment and devices within acceptable standards of the industry.

(2) Perform the skills required in the testing analysis of electronic circuits and systems using electronics, test and measure equipment while demonstrating a logical troubleshooting procedure.

(3) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

(4) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic and mechanical principles to form sound trade judgments.

(5) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(6) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude and an appreciation of craftsmanship; as needed for successful employment in the industrial electronics trade.

(7) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the industrial electronics trade.

(8) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods, and procedures of operation the student should be able to perform:

(1) The use of measuring instruments; such as, meters, bridges, oscilloscopes, and signal generators as applied, regulated power supplies, amplifiers, oscillators, logic devices, and transmission lines.

(2) The use of test equipment for troubleshooting and measurement of competent parts and circuits commonly used in electronic instruments and industrial electronic circuits, isolation of faulty components using standard and special techniques—especially, those employed with transistor circuits.

(3) Measure, observe, and record frequency responses, voltage of circuits; assembly of component parts according to circuit or wiring diagrams — wave form measurements and the application of graphic techniques.

(4) Program simple problems.

F–3. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	2,000 square feet
Storage room(shelving)/wash-up	450 square feet
Tool room	150 Square Feet
Conference	120 square feet
Total	2,720 square feet

F–4. Facility Considerations for General Contract:

1. Dutch doors in tool crib
2. Compressed air—one outlet each wall
3. 3-phase buss bars overhead
4. Floor material concrete (top insulation)
5. Two water outlets—drinking fountain
6. Emergency power cut off should be placed so that no location in the shops is more than 30′ from a safety button
7. Chalkboard and tack board
8. Adequate electrical outlets 115 volt around walls and to all benches plus demonstration areas
9. 230 volt circuit, minimum one location
10. Adequate lighting
11. Two student work benches for twenty–four students, safety wired for 120 volt a.c.
12. Double door (no center post) to outside scenic drive
13. Drinking fountain
14. Clean-up area

F–5. Course Content

I. Orientation
II. Direct Current Electricity
III. Alternating Current Electricity
IV. Electron Tubes
V. Semiconductors
VI. Schematic Drawings
VII. Power Supplies
VIII. Timers—DC
IX. Timers—AC
X. Heavy Current Conductors
XI. Sequence Timers
XII. Resistance Welding
XIII. Sensors
XIV. Electronic Heaters
XV. Magnetics
XVI. Rotating Machinery
XVII. Servos
XVIII. Logic Systems

F–6. Equipment List

Volt-Ohm Milliameters (VOM) with circuit protection, standard batteries and 4″ meter face
Field effect transistors (FET) sancore or equivalent
Dual trace oscilloscopes
Signal generators, RF, and audio
Power supplies—high and low
Isolation transformers
Signal tracers
Tube checkers
Transistor checkers

Capacity checkers
Decade boxes—R & C
Sweep and marker generators
Grid dip meters
Galvanometers (1 mil., 100 mil., 100 micro., 10 mil., 10 micro., 500 micro.)
Wheatstone bridges
Electro-dynamometer
Calibrated proney brakes (compatible with lab motors)
Basic circuitry training systems—industrial type
Benches, metal work; wood top, 30 × 60 × 32″ high with shelf, back, end stops, and base lockers
Bench grinder, 8″ wheels
Drill press, ½″ chuck
Metal brake press, 36″
Vice, 6″ jaws
Strobe light
Electric drill ⅛″ chuck and assorted drills, No. 50 thru ⅜″
Adjustable wrenches, 6″–8″
Hammers
Center punches
Files, assorted
File cards
Chisels
Shears
Scissors
Spline wrench sets
Wire strippers
Soldering irons or guns, 250 watts
Hacksaws and blades
Knockout punch sets round and square
Steel rules
Scribes
Locking grip pliers
Channel lock pliers
Screwdrivers, assorted
Combination squares
Tap and die sets
Box and open end wrench sets
Wire gauges
Knibblers
Jewelers pliers and cutters
Heat sinks
Student Starter Tool Kit:
  Slip joint pliers, 6″
  Soldering iron or gun, 100 watt
  Standard screwdriver, 4″ × ⅛″
  Standard screwdriver, 6″ ×x ¼″
  Standard screwdriver, 8″ × ⅜″
  Standard screwdriver, 12″ × 1/16″
  Phillips screwdriver, 3″ × 0″
  Phillips screwdriver, 4″ × 1″
  Phillips screwdriver, 6″ × 2″
  Nut driver set, No. 6, 8, 10. 12
Soldering aid
Allen wrench set
Tube pin straightener and puller
Neon test light
Stubby standard screwdriver
Jeweler screwdriver set
Tool box
Soldering pencil, 25 watt
Long nose pliers, 6″

Diagnonal cutters, 6″

F–7. Electronics Communication

Course Objectives:

a. To obtain a thorough knowledge of basic electronic principles and theory, the application of this theory to the various components and circuitry used in the communications electronics products, and the development of the necessary manipulative and analytic skills required in this field. Each individual is encouraged to develop the attitudes, work habits, technical knowledge, appreciation for the care of tools and equipment, and skills that will enable them to advance in the communication electronics products industry according to their ability.

b. To provide information, facts, and the basic principles of the electronic communications industry:

(1) Basic Electricity as Applied to the Electronic Industry.

(a) DC circuits.

Series.
Characteristics and calculations
(voltage drop, total current, power, total resistance, etc.)
Parallel.
Characteristics and calculations
(voltage drop, total current, power, total resistance, etc.)
Combinations.
Series-parallel
(equivalent resistance, voltage drop, total current, power, total resistance, etc.)
Voltage divider calculations

(b) Measurements, standards, and tolerances as applied to voltmeters, ammeters, ohmmeters, and oscilloscopes.

Calculation of shunts for ammeters
Calculation of multiplier resistors for voltmeters
Meter sensitivity and loading effects
Ohmmeter circuitry
Oscilloscopes as voltmeters
Determination of unknown frequencies with an oscilloscope
Observing waveshapes with an oscilloscope

(c) Conductors, insulators, and semiconductors used in electronic devices.

Factors affecting resistance of copper conductors
Factors affecting conductivity of semi-conductor materials
Effectiveness of various materials as insulators

(d) Inductive devices used in electronics.

Transformer operation and calculations (phase, voltage, and current relationships, regulation)
Radio frequency inductors (RF, if, powdered iron and air core, single and double-tuned)

(e) Alternating current in electronics.

Basic concepts (RMS, effective, peak, peak to peak values)
Effect of inductance in an ac circuit
Effect of capacitance in an ac circuit

(f) Single phase circuits.

Series — R,L,C
Parallel — R,L,C
Resonance — series, parallel
R–L and Rndash;C time constants

(g) Batteries as a source of voltage for electronic devices.

Primary cells (zinc–carbon, alkaline)

Secondary cells (lead–acid, nickel–cadmium)

(2) Electronic Concepts applied to vacuum tube and solid state devices.

(a) Basic Aspects.

Static characteristics
Dynamic characteristics
Biasing
Transistor characteristics
Other semiconductor devices

(b) Electronic circuits.

Power supplies
Vacuum tube amplifiers
Semiconductor amplifiers
Oscillators (including multivibrators)

(c) Amplifiers in cascade for RF and AF.

Coupling methods
Decoupling
Frequency response
Inverse feedback
Gain or attenuation (db)
Voltage vs. power amplifiers
Optimum transfer of energy

(d) Other concepts in electronic application.

Amplitude modulation
Frequency modulation
Pulse definitions
Logic concepts

(3) Basic methods and procedures applied to maintenance, correction and adjustment of units, component parts.

Trouble identification
Methods of correction
Methods of maintenance and adjustment

F–8. Performance Objectives:

As a result of the instruction and supervised practice the students will:

a. Demonstrate the understanding of the theory of electronics principles by reading schematic diagrams and interpreting tests to repair electronic communication products and devices within acceptable standards of the industry.

b. Perform the skills required in the testing and analysis of electronic circuits and systems using test and measurement equipment while demonstrating a logical troubleshooting procedure.

c. Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

d. Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

e. Demonstrate the ability to properly manipulate and care for the hand tools, power tools and equipment of the trade, which is necessary for safe and correct usage.

f. Read and make use of information contained in various technical publications.

g. Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude and an appreciation of craftsmanship as needed for successful employment.

h. Be able to accurately estimate costs of repair and council customers regarding alternatives.

i. Demonstrate a basic understanding of business practices and principles.

j. Exhibit qualities of leadership for effective participation in the various trade organizations.

k. Exhibit an awareness and an understanding of the necessity and value of continuing education.

F–9. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	2,000 square feet
Tool room	150 Square Feet
Storage/wash-up	450 square feet
Conference	120 square feet
Total	2,720 square feet

F–10. Facility Consideration for General Contract:

Drinking fountain
Wash-up area
Ceiling may be closed, low
Nonconductive floor covering
Ample chalk board and bulletin boards
Electric shut down on each wall
Master shut-off lock type
Double outside personnel doors (no center post)
Service road access
If school is to have a TV studio, this lab would be located near the studio
Fifty-foot TV reception tower with antenna rotor
Antenna, FM reception
Antenna, vhf reception; with transformer to 75 ohm co-ax cable; combination amplifier, 40 d.b. minimum booster and distributor 75 ohm co–ax cable to each bench and demo table; and matching transformer to convert to 300 ohms. orage for fifty tool kits
Antenna UHF reception; with booster to 300 ohm uhf line to provide sufficient power to each bench and demonstration table.
Grounded duplex outlets controlled from lighted safety switch, and flush mounted feed–thru uhf and vhf outlets at each student work station
Tool room doors—dutch

F–11. Equipment List

Volt Ohm Milliameter (VOM) with circuit protection, with standard batteries and 4″ meter face
Field effect transistor meter (FET)
Dual trace oscilloscope
Service oscilloscope
Signal generator RF
Audio generator sine and squarewave
Power supply–high and low
Isolation transformer
Signal tracer
Tube checker
Transistor checker
Capacity checker
Decade boxes–R & C
Vector scope
Sweep and marker generator
Yoke and flyback checker
CRT checker
TV analyst
Field strength meter
Grid dip meter
Wheatstone bridge
Color bar generator
TV trainer –color and B & W
Test speakers 6″
Basic circuitry training system
Bench-metal work: 30″ × 60″ × 32″ high with shelf back, wood top, stops and base lockers
Bench grinder 8″ wheels
Drill press ½″chuck

Metal brake press 36″
Vice 6″ jaws
Strobe light
Variable voltage transformer (5 amp 0–130 volts)
Frequency counter
R.F. generator–high quality (5–500 MC)
Watt meter—R.F.
Load–dummy—R.F.
Electric drill ⅜″ chuck and assorted drills
Crescent wrenches: 4″, 6″, 8″
Hammer
Center punch
Files, assorted
Chisel
Shears
Scissors
Spline wrench set
Wire strippers
Soldering gun, 100 watt and 250 watt
Hacksaw and blades
Knock out punch set—round and square
Steel rule
Scribe
Locking grip pliers
Channel lock pliers
Screwdrivers, assorted
Combination square
Tap and die set
Box and open end wrench set
Wire gauge
Knibbler
Jeweler's pliers and cutters
Heat sinks
Soldering Iron—200 watt
Soldering Iron—100 watt
Large nut drivers, No. 14, 16, 18, 20
Service carts, 24″ × 30″ × 30″ high, two shelves
Magnifiers—headband type
Nutdrivers, 6 through 12
Long nose pliers 6″
Diagonal cutters 6″
Slip joint pliers 6″
Soldering gun, 100 watt
Soldering pencil, 25 watt with stand
Standard screwdriver 4″ × ⅛″
Standard screwdriver 6″ × ¼″
Standard screwdriver 8″ × ⅜″
Phillips screwdriver 3″ × 0″
Phillips screwdriver 4″ × 1″
Phillips screwdriver 6″ × 2″
Nut driver set No. 6-8-10-12
Soldering aid
Alignment tools, assorted
Allen wrench set
Tube pin straightener and puller
Neon test light
Stubby standard screwdriver
Stubby Phillips screwdriver
Jeweler screwdriver set
Tool box
Rule, steel 6′

Wrench adjustable, 4″
Standard screwdriver 12″ × 1/16

F–12. Course Content

I. Orientation
II. Direct Current Electricity
III. Alternating Current Electricity
IV. Electron Tubes
V. Semi-Conductors
VI. Basic Vacuum Tube and Solid State Circuitry
VII. Audio Devices
VIII. Receivers
IX. Transmitters
X. Television Servicing
XI. Business Practices

Appendix G
CONSTRUCTION TECHNOLOGY

G–1. Carpentry—Course Objectives:

a. The laboratory and related instruction will be based upon an occupational analysis which includes skills, attitudes and knowledge required to achieve instructional objectives for the program. The basic principles of science and matbematies, blueprint reading, local building codes, cost estimating, building materials, and structural design, with strong emphasis on construction and structural safety are integrated into the instructional units.

b. To provide trade information, theory, facts, and basic principles in the following areas:

(1) *Surveying, Layout, and Blueprint Reading.*

Interpretation of building codes, specifications and blueprints
Determining property line
Types and mounting of batter boards
Use and operation of a builder's level
Soils and soil testing
3–4–5 triangle
Determining depth of excavation

(2) *Foundation Work.*

Interpretation of building codes, specifications and blueprints
Determining elevation of footings
Principles of construction of footing and wall forms
Types of materials—strength of concrete
Providing for openings in concrete walls
Curing concrete
Use of the plumb bob in transferring lines

(3) *Concrete Walks, Floors, and Step Construction.*

Interpretation of building codes, specifications, and blueprints
Methods of placing concrete
Placing forms and screeds
Reinforcing concrete
Principles of layout forms and steps
Screeding, floating, troweling, parting, and edging concrete
Layout of railings

(4) *Floor Framing.*

Interpretation of building codes, specifications and blueprints
Girder and post installation

Selection, care and use of hand tools—saw, brace, auger bits, 100 foot tape, and hammer
Types of floors
Types of materials—wood, metal hangers, and fasteners

(5) *Wall and Ceiling Framing.*

Interpretation of building codes, specifications, and blueprints
Fabrication of lintels and corner posts
Western and balloon construction
Plumbing and bracing
Determining stud, trimmer, lintel, cripple, and rough opening size
Methods of tieing walls together
Installation and use of fire block and backing

(6) *Roof Framing.*

Interpretation and building codes, specifications and blueprints
Roof terminology and designs
Rafter layout—common, hip, valley, hip jack, valley jack, and cripple
Framing square and rafter tabler
Use of radial arm saw and portable electric saw
Use of bevel-T and plumb bob
Toe nailing
Cutting gable studs
Louvers and purpose of ventilation

(7) *Roofing.*

Interpretation of building codes, specifications and blueprints
Methods of flashing
Types of materials
Methods of applying wood shingles, composition shingles, and built–up roofing
Safety measures
Installing gutters and drain pipe

(8) *Stair Construction.*

Interpretation of building codes, specifications and blueprints
Stair design
Layout of stair horses
Use of framing square, dividers, and portable electric saw
Methods of installing finish tread and riser
Installation of handrail

(9) *Exterior Finish.*

Interpretation of building codes, specifications, and blueprints
Types of cornices and roof trim
Installation of exterior door jambs and window frames
Setting columns and beams for porch or roof overhangs
Applying siding and types of siding
Installing overhead doors
Hanging exterior doors and storm doors
Use of scriber, chisels, hand planes, and portable drill

(10) *Interior Finish.*

Interpretation of building codes, specifications and blueprints
Applying sheet rock and taping process
Applying prefinished panels
Installing door jambs
Hanging doors—swinging, pocket, and bi–passing
Applying casing, baseboard, and shoe
Laying finish flooring

Installing finish hardware—clothes rods, towel bars, mirrors, bathroom fixtures, railings, and access covers
Use of butt gauge, lock template, scraper, nail set, abrasive paper, and miter saw
Use of router, belt and oscillating sander, and portable planer

(11) *Cabinetry.*

Interpretation of building codes, specifications and blueprints
Installing prebuilt wall and base cabinets
Installing plastic laminate counter top
Building cabinets in place
Use of shaper, mortising attachment and router
Use of fasteners, clamps, and adhesives

(12) *Insulation, Ventilation and Acoustical Treatment.*

Interpretation of building codes, specifications and blueprints
Types of insulation and its application
Preparing surfaces for acoustical tile
Installing acoustical tile

(13) *Scaffolding.*

Principle of construction for double pole scaffold
Principle of scaffold with brackets
Safety as applied to scaffolding

(14) *Estimating.*

Excavation quantities
Concrete, reinforcing steel and forming materials
Floor and ceiling joists
Wall framing and sheathing materials
Roof framing, sheathing and covering materials
Outside finish materials—siding and moldings
Interior finish materials—moldings, coverings and hardware
Insulation and acoustical materials

G–2. Performance Objectives:

a. As the result of the instruction and supervised practice the student will:

(1) Demonstrate the ability to lay out and construct foundations, floor framing, walls, and roof framing to meet the requirements as called for in the blueprints and specifications within acceptable entry level standards of the industry.

(2) Apply interior and exterior trim and finish within acceptable entry level standards.

(3) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

(4) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

(5) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(6) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude, and an appreciation of craftsmanship; as needed for successful employment in the carpentry trade.

(7) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the carpentry trade.

(8) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods and procedures of operations will be performed in the following areas:

(1) *Floor Framing.*

Installation and layout of sills
Girder and post installation
Layout and installation of floor Joists
Layout and installation of bridging
Layout and installation of subfloor

(2) *Wall Framing.*

Plate layout and installation of framing members
Fabrication of lintels and corner posts
Western and balloon construction
Tying walls together

(3) *Roof Framing.*

Layout and installation of rafters from roof plan
Mounting of gable studs
Sheathing sides and gable ends
Use of power equipment

(4) *Exterior Finish.*

Install cornices
Apply courses of siding
Build and install exterior door job
Fit and hang a door
Install door stop

(5) *Roofing.*

Apply shingles
Finish to edges on various types of roofs

G–3. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	4,000 square feet
Tool Storage	150 square feet
Supply storage	100 Square Feet
Lumber/plywood storage	400 Square Feet
Conference center	120 Square Feet
Finishing room	200 Square Feet
Restroom; lockers; clean-up area	250 Square Feet
Total	5,220 square feet

G–4. Facility Considerations for General Contract:

1. Power overhead door (minimum 16′) with side personnel door
2. Service road access
3. Dust collection system to all machines
4. Compressed air
5. Panic electrical switch/master lock control
6. 18′ ceiling
7. Chalk/bulletin board
8. Water outlets at overhead door area
9. Floor drain
10. Drinking fountain
11. Adequate electrical power and receptacles
12. Outside storage building and fenced bullpen for storage of support equipment (scaffold, wheel barrows, mixers, form materials,etc.)
13. Dutch doors in tool room
14. Clean up area with 50 lockers

G–5. Major Equipment List

Circular saw, 12″, with accessories
Scroll saw, 26″
Band saw, 20″, wood and metal
Belt and disc sander, 12″ floor model

Jointer, 8″
Shaper, wood
Planter, 24″, w/blade sharpener and accessories
Mortiser, w/attachments
Radial arm saw, 12″, w/accessories
Grinder, pedestal, 7″ w/eyeshields and lights
Portable circular saw, 7″
Belt sander, 24″ × 3″
Router, w/template and extra bits, HD w/accessories
Finishing sander
Disc sander, 7″ portable
Hand drill, ⅜″
Hand drill, ½″
Sabre saw
Woodworking benches
Lumber storage rack
Scaffoldingndash;sections
Dust collector unit
Storage cabinets
Tool box storage rack, room for 50 tool boxes (lock type)
Drill press, 20″ floor model
Vacuum cleaner, HD, w/accessories

G–6. Minor Equipment List

Expansive bits No. 21 ⅝″ to 1¾″
Expansive bits No. 22 ⅞″ to 3″
Bits, power wood ¼″to 1″
Brace, 8″ wood, ratchet, self-centering chuck
Boxes, tool
Chisels
Drill, yankee push
Hammer, 16 oz. nail (curved)
Hammer, 16 oz. rip (straight)
Level, 2 ft. aluminum
Level, 4 ft. aluminum
Level, 6 ft. 6 in. aluminum
Level, 8 ft. aluminum
Nail set
Plane, block
Plane jack 14″
Plane, smooth 9″
Rule, 6″ folding
Saw, 8 pt. hand, cross cut
Saw, 11 pt. hand, cross cut
Screwdrivers, Phillips set
Screwdrivers, Yankee
Square, carpenter, aluminum
Square, cimbination
48″ Tee square, aluminum
Tin snips, straight
Coping saw
Hack saw
6″–8″–10″– adjustable wrench
Socket set ½″drive
Allen wrench set
Open-end and box combination wrench set
Wrecking bar
100′ tape
Staple gun
Extension cords, 50 ft., three-wire, heavy duty

6′ step ladder
20′ extension ladder
Lock set template and bits
Rabbet plane
32′ extension ladder
Plastic laminate cutter
Carpenters pinchers
Combination pliers
Vice grips
Nail puller
Putty knife
Oilstone, 8″
Sledge, 8 lb.
Ladder jacks
Chalk box
Circular saw set

G–7. Course Content

I. Foundations
II. Floor Framing
III. Wall Framing
IV. Roof Framing
V. Roofing
VI. Insulation

G–8. Masonry

a. Course Objectives: The laboratory and classroom instruction will be based upon an occupational analysis which includes the skills, attitudes, and knowledge required to achieve the instructional objectives of the program. The basic principles of science and mathematics, building materials and structural design, blueprint reading, local building codes, cost estimating, with strong emphasis on construction and structural safety must be integrated into the instructional units.

b. The primary objective of the vocational masonry program is to provide the student with the necessary skills and knowledge of the trade to obtain entry level employment in the masonry trade. Trade information, theory, facts, and basic principles that the student should know:

(1) *Trade Tools.*

Nomenclature
Use and selection of tools
Care and maintenance of tools

(2) *Terminology.*

Architectural terms
Construction equipment
Masonry symbols

(3) *Estimating Procedures.*

Brick–work
Mortar
Concrete
Cement–aggregate ratios

(4) *Layout procedures.*

Bonds and patterns
Story pole
Fireplace, steps and arches
Building foundations

(5) *Masonry Practices.*

Brick
Stone
Concrete
Tile
Plaster and stucco
Brick veneer and combined masonry
Fireplace and chimney
Jointing

(6) *Safety.*

Eye protection
Acid and other caustic materials

(7) *Materials of the Trade.*

Cementing materials
Ties and connectors
Aggregates
Reinforced concrete

G–9. Performance Objectives:

a. As a result of the instruction and supervised practice the student will:

(1) Lay brick, blocks and set tile in a straight line or any other structural or decorative shape, with the proper amount of mortar as required in the blueprint specifications.

(2) Interpret and relate building codes to the actual work as required in the masonry trade.

(3) Demonstrate the ability to finish cement with the acceptable entry level regulations of the industry.

(4) Exhibit a safety awareness which is reflected in good work habits including cleanliness, orderliness, and habits of safe practice.

(5) Demonstrate the necessary technical knowledge and comprehension of scientific, mathematic, and mechanical principles to form sound trade judgments.

(6) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade, which is necessary for safe and correct usage.

(7) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude, and an appreciation of craftsmanship; as needed for successful employment in the masonry trade.

(8) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the masonry trade.

(9) Exhibit an awareness and an understanding of the necessity and value of continuing education.

b. Trade skills, methods, and procedures of operation the student should be able to perform:

(1) *Layout Procedures.*

Layout the bond
Meeting length and width dimensions
Meeting height dimension correctly
Providing for a straight wall
Construction of leads

(2) *Work Practices.*

Skill with trowel, hammer, cutting chisel, level, and jointer
Lack of waste motion
Efficient location and use of materials

(3) *Quality of Completed Work.*

Uniformity of joints
Plumb
Level
Straight
Square
Accuracy in meeting dimensions

General overall appearance

G–10. Course Content

I. Bricklaying
II. Blocklaying
III. Tile Setting
IV. Cement Finishing
V. Chimney and Fireplace Construction
VI. Mortar Composition
VII. Building Codes and/or Standards
VIII. Union Affiliations

G–11. Major Equipment List

Nugget goldblatt masonry saw, gasoline powered engine with wet cut kit and carton of ten blades
Mortar box, 16 ga. steel, 6 cu. ft. capacity
Trowler, power, 36″ with 6 hp., 4 cyl. engine and four combination blades
5½ cu. ft. mortar mixer, muller with misc engine
Seaway heavy duty scaffold (sections)
Subgrade vibrator (ground pounder)
5 ½cu. ft. concrete mixer with misc engine
Concrete buggy, 3 cu. ft. capacity

G–12. Minor Equipment List

Bricklayers apprentice tool kit consisting of 1 bag, 6′ spacing rule, 48″ mahogany level, narrow heel London trowel, hammer No. 3 brick set, ⅜″ × ½″ jointer, ⅝″ × ¾″ jointer, 5½″ pointing trowel, 250 ft. yellow line and corner blocks
Levels 24″ brass bound mahogany
Chalkline reels, 100′
Brick clamps
Mortar hoes
Rubbing bricks 6″ × 3″, 60 grit with handle
Cement edger 6″ × 2½″ × ¼″ radius
Cement groover 5½″ × ⅜″ groove stainless steel
Hammers, true temper, 16 oz. nail
Wrecking bars 30″
Framing square 16″ × 24″
Cement finishing trowels 4″ × 16″ stainless steel
Face shields
Rubber gloves
Electric drills ½″ variable speed
Hand saw, electric, 7¼″, 115V, 105 amps.
Elmer's Midget Helper
Extension cord grounded heavy duty 12–3 50′ length with male and female plugs
Hose, water—extra heavy duty with brass couplings
Bolt clippers, 30″ long, ½″ cap.
Bonded braided nylon line, 500′ tube
Skate wheel joint rakers
Shovel, 9¾ × 11¾, square point with straight handle
Bricklaying corner poles with veneer scales
Shovels, 8¾″ × 11½″, round point with straight handle
Screed 1″ × 4″ × 6′ and 2″ × 4″ × 12′, magnesium
Bull float 48″ × 8″ with 6′ and 10′ × 1¾″ diameter handles
Magnesium concrete rakes, 19½″ × 4″ deep
Walking edger, stainless steel
Walking groover
Hand saw, 36″ cross cut, 18 teeth
8″–10″ linestretcher for block
4″–6″ linestretcher for block
4 pound sledge hammer

Tool box, metal with the following tools:
5 screwdrivers assorted sizes
2 pairs 8″ pliers
1–10″ crescent wrench
5 combination end wrench
5 assorted star drills
1 pk line twigs
1 pair 10″ tin cutters
12 mason spacing tapes
2 reason modular tapes
100″ Stanley tapes
Air test meter
Gram scales
Grease gun
Pounds scales
Long handle acid brush
Wire brush with scraper
Utility brush
Extension ladder, 36 ft. aluminum
Pry bar, 5′ long
Pick mattox
Hatchet
Hacksaw, adjustable, 10″–12″ with blades
Side cutting pliers, 8″
Magnesium floats, 14″ × 3½″ cap.
Margin trowels, 5″ × 2″ blade stainless steel
Farm tank (curing concentrate)
Slump cone and rod
Level, builders dumpy with wide frame fine extension tripod and four rods with targets
Sledge, 6 lbs.
Sledge, 12 lbs.
Posi-lok broom 24″
Power hammer drill ½″, 115v., 60 cy.
Oilers, 3″ spout
Heavy weight convex ½″ jointer
Hoist arm heavy duty with 12″ well wheel for scaffold

G–13. Plumbing—Course Objectives:

To provide trade information, theory, facts, and basic principles in the following major areas:

a. The Physical Properties and Characteristics of Commonly Used Materials and Supplies in Dealing with Soil, Waste, and Venting.

Soil and vent pipes
Soil and waste stacks
Types and uses of traps
Vent pipe grades and connections

b. Operating Principles and Installation of Stacks, Pipes, Drains, and Sewers.

Installation of traps
Trap levels and protection
Operating principles of traps
Location and installation of cleanouts
Principles of venting
Vent pipe grades and connections
Circuit venting
Branch and individual vents
Small fixture units and venting
Location and operation of drains

c. Installation and Principles of Operation of Building Drains and Sewers.

Old building sewers and drains
Size of drains, sewers and horizontal branches
Systems of sewers and drains
Storm and sanitary sewer system
Location of sewers and drains
Subsoil drainage
Operation of septic tanks

d. Installation and Operation of Storm Water Drains.

Subsoil, foundation, clear-water and absorption tile drains
Wastes and connections to the sewerage system
Provisions for overflows

e. Water Supply and Distribution–Fixture Units.

Types of fixtures and their installation
Water supply control
Water supply pipes, fittings and materials
Water supply to fixtures
Water pressure control-water hammer
Principle of operation of fixtures
Number of fixtures per branch
Valves of various kinds
Control of quality of water

f. Plumbing Fixtures (Water supply and soil, waste and venting).

Types and kinds of fixtures
Principle of operation of water closets
Control of fixture overflow
Grease control traps
Principle of operation of seals
Fixture strainers
Code requirements governing the number, kind and installation of fixtures

g. Industrial and Special Wastes.

Types and characteristics of industrial and special wastes
Materials and special pipes required
Overflow pipes and water lift exhausts
Acid wastes
Garage waste

h. Inspection and Tests.

System tests
Alterations, repairs and extensions
Methods of Testing

i. General Trade Information.

Types of solder and soldering practices
Application of knowledge of gases to the trade
Application of basic bacteriology to sewage disposal, septic tanks, and cesspools
Prevention of contamination of water supply
Causes and prevention of electrolysis
Formation and prevention of gases and odors of various kinds
Knowledge of trade hazards and safety precautions
Basic calculations involving layout repairs and alteration:
  Determination of pitch of drains, sewers, soil pipe
  Determining lengths of pipe required for an installation
  Calculating bends and offsets in pipe
Interpretation of working drawings and isometrics used by the tradesman

Application of the basic principles of mechanics to the work of the trade

G–14. Performance Objectives:

As a result of the instruction and supervised practice the student will perform trade skills, methods, and procedures of operations in the following areas:

a. Work from Builder's or Architect's Drawings.

Lay out and locate pipes for waste and supply
Determine size, kind and type of pipe
Determine types of joints and connections

b. Rough-in Standard Installations.

Cutting ferrous, nonferrous and clay pipe
Threading of pipe
Join pipes—make and caulk joints

c. Install Fixtures and Accessories on a Variety of Materials—Toilets, Wash Basins, and Others. Paragraph not used.

d. Testing Systems. Air or water test.

G–15. Tools and Equipment List

Augers, hand
Bending block and pins
Calipers
Carpenter's square
Caulking and packing irons
Chain tongs
Chain vise
Chalk line
Chisels, assorted
Circumference rule
Combination square
Dividers or trammels
Electric arc welder
Files, assorted
Flaring tool and block
Folding rule
Framing square
Hand drills and bits
Hand hacksaw
Hand pipe threaders
Hand pipe cutters and reaming tools
Handsaws
Hand shears
Hot air torch
Inert gas metal arc welder
Ladders
Marking or scratch awls
Mattock pick
Melting furnace
Metal scrapers
Orifice meter
Oxyacetylene torch
Pedestal and bench grinders
Personnel hoists or lifts
Pipe taps
Pipe threading dies
Pipe vise
Pliers, assorted
Plumb bob

Plumber's ladle
Portable air or electric drills
Portable circular or saber saws
Portable grinder
Portable power saws
Powered pipe cutters, threaders, and reamers
Powered rodding Equipment
Propane torch
Punches, assorted
Retractable steel measuring tapes
Scaffolds
Screwdrivers, assorted
Scriber
Shovels, assorted
Slings and hoists
Soldering irons
Spirit level
Strap wrench
Swaging tools
Transit and tripod
Tube cutter or reamer
Vacuum plunger
Wrenches, assorted

G–16. Construction Electrician—Course Objectives:

a. The emphasis is on each student to master the manipulative skills, as well as develop skill in the proper care and safe use of tools and equipment being used in the field of construction electricity. Technical instruction covers training in mathematics, electrical theory (A/C and D/C), national and local electrical codes, wiring methods, blueprint reading and layout. Each student demonstrates at his own rate, as demonstrated by his ability and application to the tasks. It is inherent in this type of instruction that emphasis be put on individual instruction, demonstration and application.

b. To provide trade information, theory, facts, and basic principles in the following major areas:

(1) *Reading of Working Instructions.*

Interpretation of floor plans, schematics and wiring diagrams — recognition of symbols
Interpretation of specifications
Interpretation and application of the national electric code

(2) *Utilization of the National Electric Code.*

Responsibility for enforcement
Major provisions of concern to the electrician
National and local relationships for the application and modification of code provisions

(3) *Safety Practices and Regulations.*

Work safety practices and standards
Safety regulations concerning the installation and operation of rotating machinery and equipment
Special code regulations concerning light and power circuits and controls

(4) *Principles, Practices and Procedures for Installation of Electric Power for Residential, Commercial, and Industrial Structures.*

Quality and workmanship
Wiring practices and procedures:
- Layout
- Conduit
- Cable
- Bx
- Single and multiphase
- Welding procedures

(5) *Principles of Operation and Installation of Controls and Rotating Equipment.*

Ac–dc motors-generators
Circuit controls
systems–
  Solid state
  Remote
  Air–temperature
  Sound

(6) *Principles of Electronics Applied to Electrical Installation.*

Static systems
Solid state systems (semiconductors)
Test equipment

(7) *Basic Principles of Electricity and Magnetism and Their Application in the Trade.*

Series, parallel and combination circuits (theory and calculations)
Ac–dc machinery and equipment
Power generation and controls
Principles of lighting circuits and controls
Principles of communication systems and controls
Signal
Alarm
Sound

(8) *Trade Calculations.*

Material requirements
Wire size and load calculations

(9) *Preventive Maintenance and Troubleshooting.*

Code provisions for maintenance
Use of instruments and tools
Rotating machinery and equipment controls and circuits

(10) *General Trade Information.*

Employer — employee relationship
Business — customer relationship
Payroll and time calculations

G–17. Performance Objectives:

a. As a result of instruction and supervised practice the student will:

(1) Exhibit the necessary skills and knowledge which will permit the student to enter into, and advance in, the construction electricity field.

(2) Read and interpret blueprints, plans and specifications of the construction electricity trade.

(3) Demonstrate the ability to properly manipulate and care for the hand tools, power tools, and equipment of the trade which is necessary for safe and correct usage.

(4) Exhibit a safety awareness which is reflected in good work habits, including cleanliness, orderliness, and habits of safe practice.

(5) Demonstrate the ability to analyze electrical problems and plan logical methods of repair or replacement.

(6) Define the terms and symbols of the trade.

(7) Exhibit qualities of self-confidence, initiative, excellence in performance, a cooperative attitude and an appreciation of craftsmanship, as needed for successful employment in the construction electricity trade.

(8) Exhibit qualities of leadership for effective participation in the various organizations affiliated with the trade.

b. Trade skills, methods and procedures will be performed in the following major areas:

(1) *Layout and Print Reading.*

Code interpretation
Selection of materials and supplies

Plan wiring installations according to NEC regulations

(2) *Installation, Testing and Operation of Controls.*

Distribution system, domestic-commercial (single and/or multiphase)
Install and/or mount equipment on various surfaces found in buildings
Mount various kinds of starters and switches

(3) *Installation of Residential, Commercial Wiring.*

Wiring methods (Bx, conduit, EMT)
Signal systems and alarms
Lighting-heating-air conditioning wiring

(4) *Testing and Troubleshooting of Installations.*

Rotating equipment
Signal systems
Alarm systems
Starters—switches

(5) *Code Applications.* Paragraph not used.
(6) *Safety.* Paragraph not used.

G–18. Facility Specifications

Minimum Square Foot Requirements:

Laboratory	2,000 square feet
Tool Room	100 square feet
Supply/parts room	100 Square Feet
Restroom and lockers	250 Square Feet
Conference center	125 Square Feet
Total	2,570 square feet

G–19. Facility Considerations for General Contract:

1. Overhead door minimum 12″
2. Personnel door
3. Adequate electrical outlets around wall and to bench areas
4. Electric power service box for wiring instruction (all types and size service)
5. Master control power shut-off
6. Motor test area adequately wired
7. Compressed air outlet
8. Chalk/bulletin board
9. Area for room construction for wiring practice
10. Tool room door of dutch door type
11. Water fountain
12. Wash up area

G–20. Equipment List

Bench-student equipped with variable A/C and D/C power supplies and metering
Audio generators
Oscilloscopes
Multimeters
Circuit boards and mounting frames
Hydraulic conduit bender, ½″ thru 4″
A/C D/C milliammeters
Wattmeters
Recording ammeter
Capacitance decade box
Resistance decade box
Transistor analyzer

Capacitor analyzer
Tube tester
Vacuum tube voltmeters
Hand drill motor, ⅜″ chuck
Hand drill motor, ½″chuck
Set of drills, 1/16″ thru ⅜″
Set of drills, ⅜″ thru ½″
Drill press (bench mounted)
Bench grinder with 8″ course and fine wheels
Work bench 30″ × 60″ × 32″ high with shelf, back, end stops and base locker
Pipe cutter and reamer, ½″ thru 3″
Phillips screwdriver
Common screwdriver
Bench brushes
Push brooms
Direct current, circuit kits
Basic circuit kits
Alternating current, circuit kits
A/C motors, ⅛ hp. thru 1 hp.
A/C motor starters
D/C generators
Hand saw, 8 pt. cross cut
Meggar
"Jumping Jack"
Basic elecrical training kit—laboratory experiment
Motor trainer kit
Knock Out (K.O.) cutter
Step ladder, wood, folding, 8′
Bench vise, heavy duty, 8″ jaw
Fish tape
Soldering pencil, 40 watt
Soldering gun, 100/140 watt
Soldering gun, 240/325 watt
Grinding wheel dresser
Tin snips
Diagonal pliers, 7″
Fuse puller
Cold chisels, ¼″, ⅜″, ½″, ¾″, and 1″
"Channellock" pliers
Side cutter pliers, 7″
Needle nose pliers, 5″
Crimping pliers, 8″
Common pliers, 6″
"Allen"wrenches
Wood brace 8″, ratchet, self-centering chuck
Wood auger bits, ¼″ thru 1″
Metal files w/handles (assorted bastard and mill)
File cards
Prick punches
"C"clamps, 6″
Crescent wrench, 8″
Putty knife, 1″
Tri square
Framing square
1′ metal rule
3′ metal rule
Hack saw with 6 blades each
Nut driver set
"T"square
Ball peen hammer, 8 oz.
Plastic face hammer, 8 oz

Awl
Pipe wrench, 3″ jaw
Pipe die set, ½″ thru 3″
Conduit bender ½″, ¾″ and 1″

G–21. Course Content

I. Orientation
II. Direct Current Electricity
III. Magnetism
IV. Dc Power Sources
V. Dc Motors and Controllers
VI. Instrumentation
VII. Alternating Current Electricity
VIII. Ac Circuits
IX. Three Phase ac Electricity
X. Transformers
XI. Ac Motors and Starters
XII. Electronics
XIII. Planning and Layout
XIV. Branch Circuits
XV. Wiring Methods
XVI. Lighting
XVII. Heating and Air Conditioning
XVIII. Low Voltage Systems

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